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Sustainable development: promotion of new and renewable sources of energy

Promotion of new and renewable sources of energy

Report of the Secretary-General

Summary

Access to affordable, modern energy services is a prerequisite for the achievement of sustainable development and the Millennium Development Goals. New and renewable sources of energy can play a crucial role in providing needed energy access, supporting and accelerating economic and social development, creating employment opportunities, reducing greenhouse gas emissions and ensuring energy security. Rising global energy demand requires greater energy diversification and an increase in the share of new and renewable energy in the future global energy supply. The current share of renewable energy in the global energy supply is still low, however, in spite of its vast potential, because of the high costs of many renewable energy technologies. It is therefore of utmost importance to increase the cost-competitiveness of renewable energy technologies by adopting and implementing policies that ensure research, development, deployment and transfer of those technologies, especially to developing countries. Policies can stimulate the required public and private investment at the local, national and international levels and encourage public-private partnerships and international cooperation.

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I. Introduction

1. The General Assembly, in its resolution 62/197, reaffirmed the need for the full implementation of the Plan of Implementation of the World Summit on Sustainable Development (Johannesburg Plan of Implementation)[1] as the intergovernmental framework for energy for sustainable development. The Assembly encouraged the United Nations system to continue to raise awareness of the importance of energy for sustainable development and poverty eradication, including the need for the promotion of new and renewable sources of energy, and of the increased role that they could play in the global energy supply.

2. In recalling the 2005 World Summit Outcome (resolution 60/1), the General Assembly welcomed initiatives aimed at improving access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services for sustainable development in order to contribute to the achievement of internationally agreed development goals, including the Millennium Development Goals (resolution 55/2). The Assembly encouraged global, regional and national initiatives on new and renewable sources of energy to promote access to energy for the poorest and to improve energy efficiency and conservation by using a mix of available technologies. It also emphasized the need to intensify research and development in support of energy for sustainable development. The Assembly recognized the contributions of new and renewable sources of energy to the reduction of greenhouse gases and addressing climate change. The Assembly also called on the international community to support least developed countries, landlocked developing countries and small island developing States in their efforts to develop and utilize energy resources, including new and renewable energy.

3. The General Assembly requested the Secretary-General to submit to it at its sixty-fourth session a report on the implementation of its resolution 62/197. The present report is submitted pursuant to that request.

4. The Commission on Sustainable Development continues to play a pivotal role as a forum for discussion, review and formulation of policy options and concrete actions on energy for sustainable development. The Commission explicitly considered energy for sustainable development as one of the thematic clusters at its fourteenth and fifteenth sessions. In 2008/2009, the Commission addressed the thematic cluster on agriculture, rural development, land, drought, desertification and Africa and agreed to improve access to reliable and affordable energy services, including renewable and alternative sources of energy, for sustainable rural development. In resolution 17/1 (see E/2009/29 (Supp), chap. I, para. b), the Commission also called for increased public and private investment in electrification facilities in rural areas and for domestic and foreign investment in renewable energy and energy efficiency in Africa.

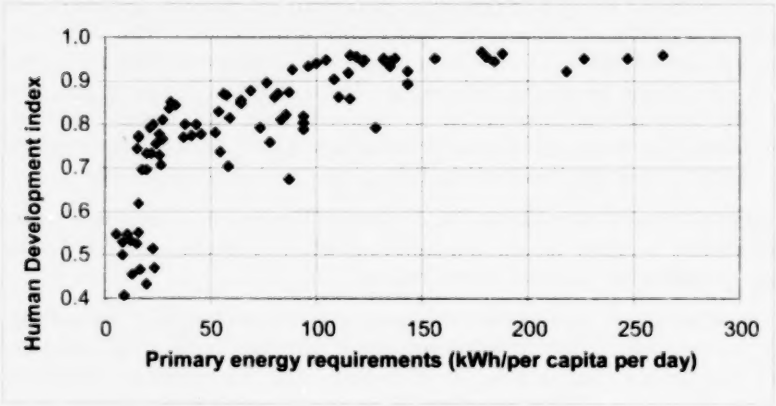
[1] *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August-4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 2, annex.

II. Energy for sustainab'e development

5. Today's main energy challenges are to urgently ensure energy sustainability and security, to protect the climate by cutting greenhouse gas emissions and to support developing countries in their efforts to achieve access to affordable modern energy services. Access to and affordability of sustainable energy services are prerequisites for economic growth, human and social development and the achievement of the Millennium Development Goals.

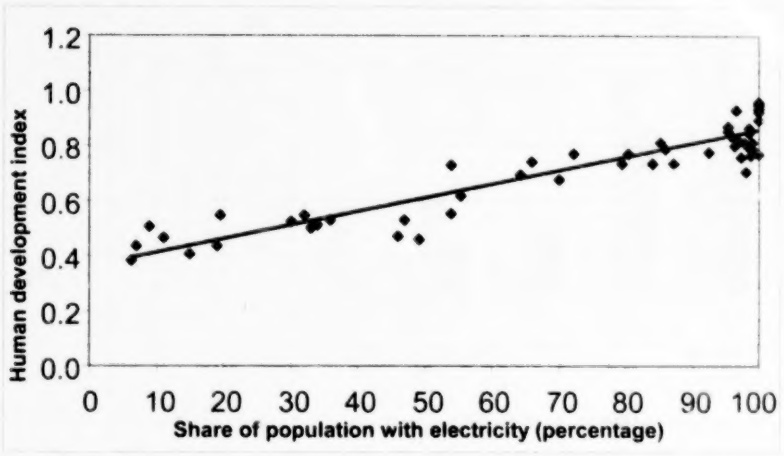
6. The experiences of many countries during the past several decades show that higher levels of development are linked to sufficiently high levels of energy consumption. That relation is demonstrated by the fact that most of the countries with a high level of development, as measured by a human development index of at least 0.9, consume considerable amounts of energy (see figure 1 below). Also, the populations of all countries that have reached a high level of development have close to 100 per cent access to electricity (see figure 2 below).

Figure 1
Human development index and total primary energy requirements



Source: United Nations Development Programme (UNDP), *Human Development Report 2007/2008* (New York, 2007); International Energy Agency (IEA), *World Energy Outlook 2008* (Paris, Organization for Economic Cooperation and Development (OECD)/IEA, 2008).

Figure 2
Human development index and share of population with electricity



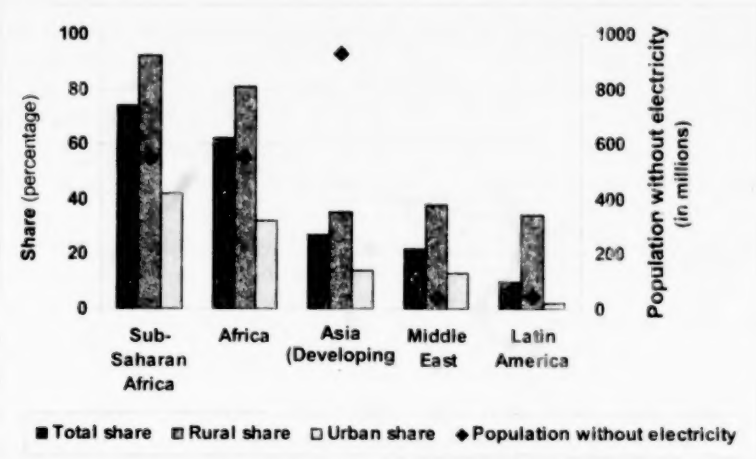
Source: UNDP, *Human Development Report 2007/2008* (New York, 2007); IEA, *World Energy Outlook 2006*.

7. An estimated 1.6 billion people in developing countries still lack access to electricity, particularly in sub-Saharan Africa, South Asia and some small island developing States (see figure 3 below). Especially in sub-Saharan Africa and mainly in rural areas, the majority of the population still lacks access to modern energy and has an excessive dependence on traditional forms of biomass energy (see figure 4 below). Globally, an estimated 2.4 billion people continue to rely for cooking and heating on traditional biomass in the form of firewood, charcoal, manure and crop residues, which imposes serious health risks, particularly as a result of indoor air pollution.[2] Moreover, the use of traditional biomass has negative environmental, climate, social and economic impacts.[3]

[2] The World Health Organization (WHO) estimates that 1.5 million die each year from the effects of indoor air pollution, translated into 4,000 deaths per day. In sub-Saharan Africa alone, 396,000 deaths from indoor air pollution were reported in 2002 (WHO, *Fuel for Life: Household Energy and Health* (Geneva, WHO Press, 2006)).

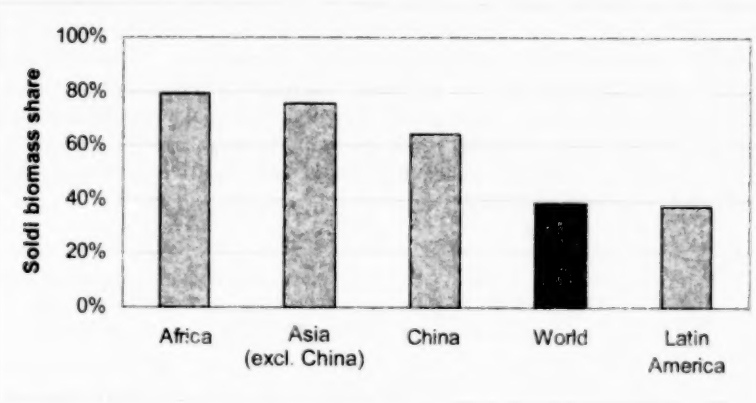
[3] Most biomass is collected outside of the commercial economy, imposing immense burdens on women and sometimes children, who spend a lot of collection time that therefore cannot be spent on education and employment activities. Moreover, the use of traditional biomass spurs deforestation, which itself contributes substantially to greenhouse gas emissions.

Figure 3
Share of population without electricity by developing region



Source: IEA, *World Energy Outlook 2006*.

Figure 4
Shares of solid biomass in total residential energy consumption for major regions in 2006



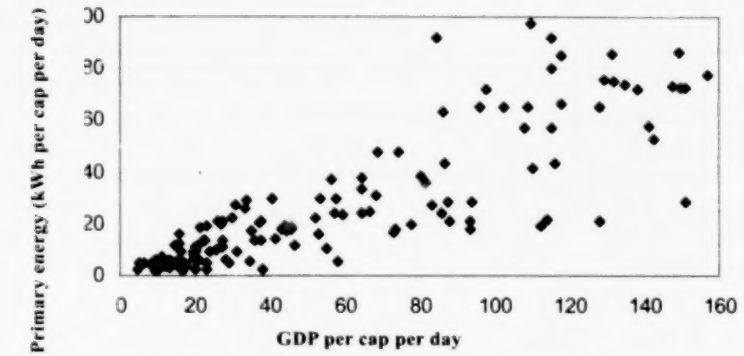
Source: IEA, *Energy Balances of Non-OECD Countries: 2008* (Paris, OECD Publishing, 2008).

8. Higher levels of income are correlated to higher consumption of energy, as illustrated by country data on per capita gross domestic product (GDP) and per capita primary energy use (see figure 5 below). Moreover, a global comparison of household expenditures for fuel and electricity reflects that, in many cases, developing countries, in particular those with low household incomes, have to allocate larger shares of their income to cover energy expenditures than developed countries, making the affordability of modern energy services even more challenging (see figure 6 below). Many people in developing countries live in very

limited economic conditions that allow them to satisfy only basic needs for human subsistence, such as food and shelter, and they therefore simply cannot afford to pay for modern energy services, even if those services are available.

Figure 5

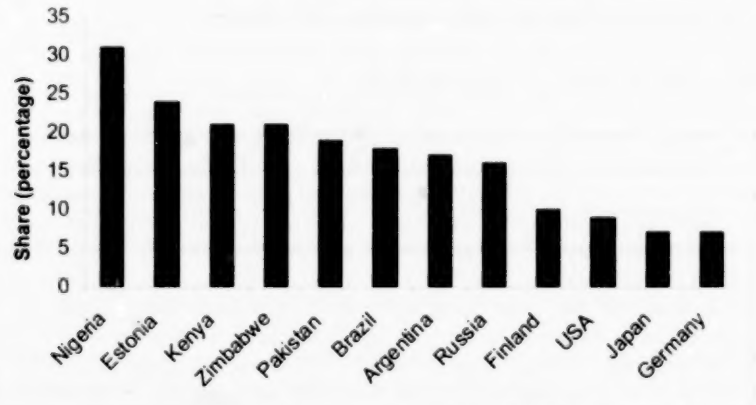
Per capita primary energy use and per capita gross domestic product in countries of the world



Source: International Energy Agency (IEA), World Energy Statistics and Balances 2009, database, accessed on 29 July 2009.

Figure 6

Share of household expenditures for fuel and electricity in selected countries



Source: World Bank, *World Development Indicators 2000* (Washington, D.C., International Bank for Reconstruction and Development (IBRD)/World Bank, 2000).

9. Thus, despite the indispensable role of access to modern energy in sustainable development, affordability is a major constraint that can limit the use of some modern energy services in developing countries. Modern energy services that currently depend mainly on fossil fuels are not affordable for a large share of the

population in some developing regions. Moreover, fossil fuel importing, medium- and low-income economies are particularly vulnerable to price volatility and price increases, which could upset their external payments balance, cause economic instability at the macro level and prevent Governments from investing in technical and social infrastructure, resulting in higher energy costs for households.

10. The promotion of new and renewable energy, including concentrating solar power, solar thermal, solar photovoltaic, modern biomass (including biofuels), wind (onshore and offshore), hydro, ocean and geothermal, could considerably stabilize domestic energy security by reducing the amount of absolute imports and broadening the diversity of electricity and fuel sources, hedging against fluctuating and increasing fossil fuel prices. An expansion of the national renewable energy sector could also create local employment opportunities.

11. The costs of many renewable energy technologies are still higher, however, than conventional energy technologies; therefore, those costs need to be considerably reduced so that developing countries can afford them. To reduce those costs, an enhanced effort on research, development and transfer is essential, which needs to be supported by adequate policies and private and public investment through international cooperation.

12. Only once the costs of renewable energy technologies are reduced and those technologies become affordable and economically viable for developing countries can the increased use of new and renewable sources of energy provide the needed access to reliable, socially acceptable and environmentally sound energy services that can also considerably contribute to addressing climate change. In addition, conservation of energy and energy efficiency offer important options that could improve sustainable energy development.

III. Global overview of new and renewable energy

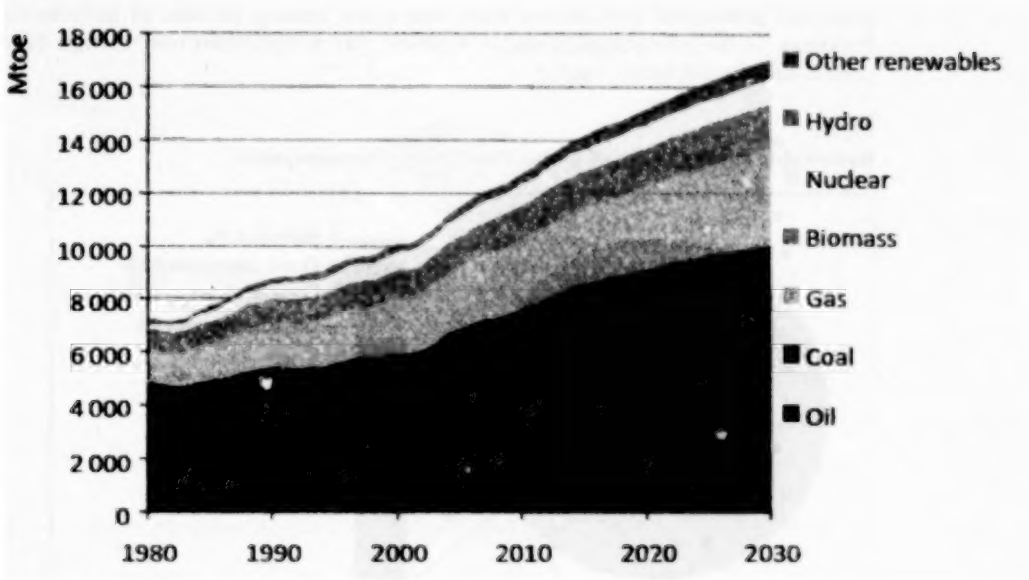
A. Overview of the global energy market

13. Global energy demand amounted to 11,730 million tons of oil equivalent in 2006 and is continuously rising, with a projected increase in the world's population to more than 8 billion by 2030 and rapid economic expansion and industrialization, especially in non-OECD countries (see figure 7 below). Global energy supply still relies largely on fossil energy sources, mainly oil, gas and coal. In the reference scenario of the International Energy Agency (IEA), world primary energy demand is projected to increase 45 per cent from 2006 to 2030.[4] Total energy demand in non-OECD countries is foreseen to increase by 73 per cent, compared with 15 per cent in OECD countries.[5] Energy supply would continue to be based primarily on fossil fuels, with coal projected to account for more than a third of incremental global energy demand through 2030. Those resources are limited, while their use continues to have negative impacts on the environment, climate and human health.[4]

[4] IEA, *World Energy Outlook* 2008 (Paris, OECD/IEA, 2008).

[5] Energy Information Administration of the United States of America, *International Energy Outlook 2009* (Washington, D.C., 2009).

Figure 7
World primary energy demand by fuel in the International Energy Agency reference scenario



Source: IEA, *World Energy Outlook* 2008 (Paris, OECD/IEA, 2008).
Abbreviation: Mtoe means million tons of oil equivalent.

14. In the reference scenario of IEA, CO_2 emissions would increase by 1.6 per cent per year, amounting to an increase of 45 per cent by 2030 from their 2006 levels of 28 gigatons.[4] In 2050 energy-related CO_2 emissions could reach 62 gigatons, resulting in an eventual global average temperature increase of up to 6° C. The reference scenario would imply a 25 per cent increase in global oil demand by 2030, which would be unsustainable not only from a climate change perspective but possibly also from an economic and security perspective.[6]

B. Overview of the status of renewable energy

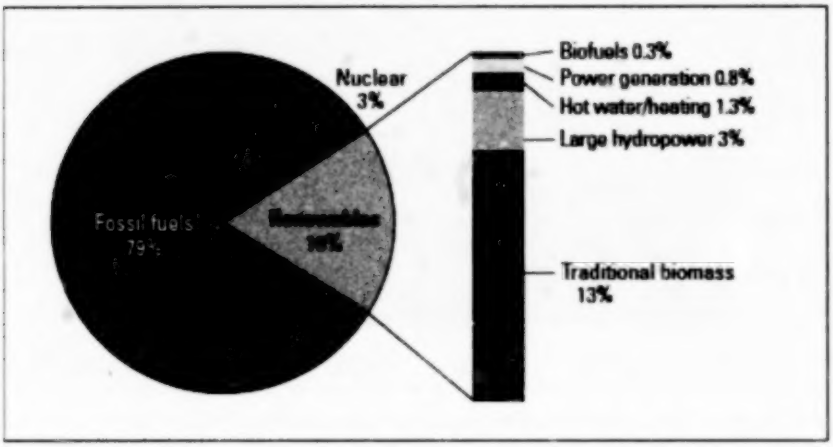
15. Renewable energy contributes in the main areas of electricity generation, water and space heating, transport fuels and rural (off-grid) energy. There has been remarkable growth and penetration of renewable energies into global markets in recent years, though the share in global energy supply remains low (see figure 8).[7] Renewable energy from wind, solar, small hydro (excluding large hydro), modern biomass (including biofuels but excluding traditional biomass) and geothermal

[6] IEA, "Ensuring green growth in a time of economic crisis: the role of energy technology" (OECD/IEA, 2009).

[7] When using the term "renewable energy", large hydropower and traditional biomass are excluded in the present report, as other sources of renewable energy like wind, solar, small hydro, modern biomass (including biofuels) and geothermal are rather "new" and need more market and policy support in promoting their use in order to exploit their future potential.

supplies 2.4 per cent of the world's final energy consumption. Renewable energy comprises about 5 per cent of global power-generating capacity and supplies about 3.4 per cent of global electricity generation. Wind currently has the largest share in renewable electric power capacity, followed by small hydro (see figure 9). Biomass, solar and geothermal provide hot water and space heating for tens of millions of buildings. In the transportation sector, biofuels play a significant role, though their contribution is still rather small.[8]

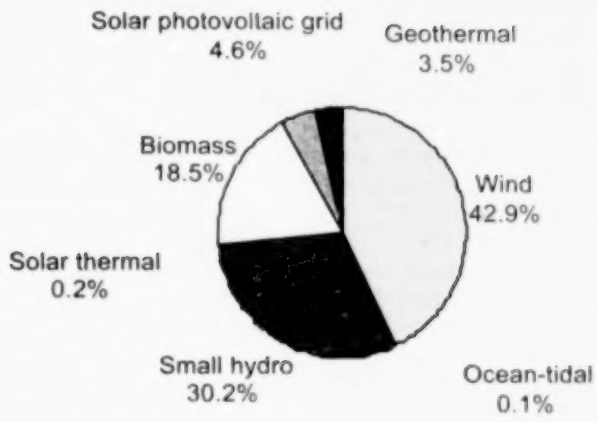
Figure 8
Renewable energy share of global final energy consumption



Source: REN21, "Renewables 2007: global status report", 2008 (Paris, REN21 secretariat, and Washington, D.C., Worldwatch Institute, 2008).

[8] Renewable Energy Policy Network for the 21st Century (REN21), "Renewables 2007: global status report" (Paris, REN21 secretariat, and Washington, D.C., Worldwatch Institute, 2008).

Figure 9
Renewable electric power capacity



Source: REN21, "Renewables: global status report: 2009 update" (Paris, REN21 secretariat, 2009).

16. In 2008 power capacity added from renewable energy surpassed for the first time power capacity added from conventional sources in the European Union and in the United States of America. Global renewable electricity capacity reached 280 gigawatts (GW) in 2008, indicating a 16 per cent increase from the 240 GW in 2007 (see table 1 below). Notably, developing countries increased their renewable energy capacity to 119 GW in 2008. As at the end of 2008, China had renewable power capacity installations of 76 GW, the United States 40 GW, Germany 34 GW, Spain 22 GW, India 13 GW and Japan 8 GW. The renewable heating market also continued to expand to 450 gigawatts-thermal (GWth) in 2008. In the transport sector, fuel ethanol production increased considerably, to 67 billion litres in 2008. Growth rates of biodiesel are immense (a six-fold increase), though absolute numbers are still less than ethanol.[9]

Table 1
Renewable energy added and existing capacities in 2008

Technology	*Added during 2008*	*Existing at end of 2008*	*Comments*
Power generation (GW)			
Large hydro	25-30	860	Still the largest renewable source of electricity, although resettlement impacts, availability of sites and environmental constraints limit growth

[9] REN21, "Renewables: global status report: 2009 update" (Paris, REN21 secretariat, 2009).

Technology	*Added during 2008*	*Existing at end of 2008*	*Comments*
Wind	27	121	Onshore wind: increased especially in the United States, Germany, China and India; Offshore wind: reached almost 1.5 GW; mostly applied in Europe
Small hydro	6-8	85	Particularly increased in several Asian and African countries
Biomass	2	52	Grew considerably at large and small scales in the European Union countries and several developing countries
Solar photovoltaic, grid-connected	5.4	13	70 per cent increase; fastest growing power generation technology; increased especially in Spain, Germany and the United States
Geothermal	0.4	10	Especially in the United States, but also in several developing countries
Concentrating solar power	0.06	0.5	Many planned plants in Spain, Morocco, Algeria, Egypt, Israel and the United States
Ocean	~0	0.3	Still at early stage of development
Hot water/heating (GWth)			
Biomass	n/a	~250	
Solar collectors	19	145	Especially in China, Germany, Spain, Turkey, Japan, Israel and Brazil
Geothermal	n/a	~50	More than 76 countries use direct geothermal energy
Transport fuels (billion litres/year)			
Ethanol	17	67	Especially in Brazil and the United States
Biodiesel	3	12	Two thirds of it produced in the European Union

Source: REN21, "Renewables: global status report: 2009 update" (Paris, REN21 secretariat, 2009).

C. Potential of renewable energy

17. The technical potential for renewable energy is vast, several times the current total energy demand. Global electricity consumption in 2050 is projected to be between 113 and 167 exajoules (EJ),[10] whereas the technical electricity potential of renewable energy technologies is almost 2500 EJ/year, excluding traditional biomass. The estimated global potential of solar photovoltaic technology is huge, largely in Africa and the Middle East, amounting to more than 1,500 EJ/year, followed closely by concentrating solar power. The potential of onshore wind is estimated to reach nearly 400 EJ/year and of offshore wind 22 EJ/year. Ocean energy potential is estimated to be around 50 EJ/year and, for the well-established energy resources of hydro and geothermal, about 50 EJ/year for each. A rather critical area is the technical potential of bioenergy (currently assumed to be 70 EJ/year from residues and 290 exajoules per year from energy crops) that can be

[10] IEA, *Energy Technologies Perspectives: 2006*.

used for electricity generation, heat supply and transportation; however, a careful assessment is needed to determine what degree its use of land is competing with food crops and spurring deforestation. The potential for geothermal energy for heating and cooling could cover 20 times the current global heat demand, and the potential for solar water heating is almost unlimited.[11]

IV. Development and transfer of renewable energy technologies

18. An important issue affecting the future use of renewable energy relates to the research, development and deployment of new technologies and the timely transfer of those technologies to developing countries. The transfer of renewable energy technologies is not simply about the supply of equipment across national or international frontiers but also about the complex processes of creating awareness, sharing knowledge, technical training, capacity-building and adapting technologies to meet local conditions, along with the associated management demands. Effective deployment and technology transfer may need to involve the support of national, regional and international organizations from both the public and private sectors and could be based on a combination of North-South, South-South and triangular partnerships.

19. Besides informational legal, regulatory, market, institutional, infrastructural, political and cultural barriers, financial barriers are most often cited as the critical constraints for the effective development, transfer and diffusion of renewable energy technologies. Identification and prioritization of major barriers, however, are part of a country-specific process for formulating particular actions and strategies.

20. Financial barriers to technology transfer can be divided into barriers related to the investment needs for the implementation of renewable technologies (supply side) and barriers related to the costs associated with those technologies as compared with the costs of competing alternative technologies (demand side). Funding for developing renewable energy technologies is relatively difficult to obtain, partly because energy is a commodity business. That severely limits the economic margins associated with innovation. The nature of the energy market, with its slow turnover times for capital stock and, in some cases, large-scale engineering requiring costly and time-consuming demonstration projects, raises the costs and risks and may make other investment opportunities more attractive. On the demand side, energy prices normally do not reflect the full costs of energy, as they do not include the external costs related to them. Reductions in environmental, social and other impacts resulting from the use of renewable energy technologies are therefore usually not reflected in market transactions. Those price distortions further inhibit the deployment and transfer of new renewable energy technologies. At the same time, innovative energy supply and end-use technologies are often more capital intensive (although less fuel intensive) than conventional technologies, which can deter potential users. As the technology becomes more established in the

[11] Notwithstanding the large potential, the transportation costs of heat are quite high (REN21, "Renewable energy potentials in large economies — summary report" (Paris, REN21 secretariat, 2008)).

marketplace, benefits from economies of scale and learning experiences can help lower the costs significantly.[12]

V. Costs of renewable energy technologies

21. Cost estimate comparisons of energy technologies vary considerably and depend on many factors and assumptions that affect the calculations. Usually, cost comparisons are expressed in terms of "levelized energy cost", which is a comprehensive cost assessment of generating energy for a particular system determined using a net present value approach. For a power plant, levelized energy cost is an economic assessment of the cost of the electric generating system in cents per kilowatt-hour that includes all costs over its lifetime. In addition, there are other factors that may affect the calculation, such as the availability factor, e.g., factors based on solar and wind intensities, which depend on geographical location; plant capacity factors; plant size; and, if financial factors are included, the discount rate and depreciation schedules and other policy-related issues, such as subsidies and tax breaks. Consequently, most available cost comparisons diverge considerably.

22. Nevertheless, a number of organizations have developed cost comparison assessments based on several different assumptions.[13] In 2007 REN21 compiled costs for renewable energy technologies from a variety of sources, including IEA, the National Renewable Energy Laboratory of the United States and the World Bank (see table 2 below). The costs reported by REN21 are economic costs, exclusive of subsidies or policy incentives. The typical energy cost estimates are based on best conditions, including system design, siting and resource availability.

Table 2
Costs of renewable energy technologies

Technology	*Typical characteristics*	*Typical energy costs (US cents/kWh)*	*Comments*
Power generation			
Large hydro	10-18,000 megawatts (MW)	3-4	Currently one of the lowest-cost energy technologies
Small hydro	1-10 MW	4-7	
Onshore wind	1-3 MW	5-8	Blade diameter: 60-100 metres
Offshore wind	1.5-5 MW	8-12	Blade diameter: 70-125 metres
Biomass	1-20 MW	5-12	

[12] Department of Economic and Social Affairs, "Climate change and technology transfer: the need for a regional perspective", policy brief No. 18, 2009.

[13] See, for example, the Energy Sector Management Assistance Programme of the World Bank "Technical and economic assessment of off-grid, mini-grid and grid electrification technologies" (IBRD/the World Bank, 2007); Lazard, "Levelized cost of energy analysis — version 2.0" (2008).

Technology	*Typical characteristics*	*Typical energy costs (US cents/kWh)*	*Comments*
Geothermal	1-100 MW	4-7	Types: binary, single- and double-flash, natural steam
Rooftop solar photovoltaic	2-5 kW-peak capacity	20-40	For low latitudes with solar insulation of 2,500 kWh/m²/year;
		30-50	For 1,500 kWh/m²/year (typical of southern Europe);
		50-80	For 1,000 kWh/m²/year (higher latitudes)
Concentrating solar power	50-500 MW (trough) 10-20 MW (tower)	12-18	Costs for trough plants; costs decrease as plant size increases; a rapidly maturing technology
Hot water/heating			
Biomass heat	1-20 MW	1-6	Most cost-competitive renewable energy technology for heating
Solar	2-5m² (household)	2-20	Household Medium Large Types: evacuated tube, flat-plate
	20-200m² (medium)	1-15	
	0.5-2 MWth (large/district heating)	1-8	
Geothermal	1-10 MW	0.5-2	Applied for heating and cooling; Types: heat pumps, direct use, chillers
Biofuels			
Ethanol	Sugar cane, sugar beets, corn, cassava, wheat,	25-30 cents/litre (sugar)	Gasoline equivalent
	Sorghum (and cellulose in future)	40-50 cents/litre (corn)	Gasoline equivalent
Biodiesel	Soy, rapeseed, mustard seed, jatropha, palm, waste vegetable oils	40-80	Diesel equivalent

Technology	*Typical characteristics*	*Typical energy costs (US cents/kWh)*	*Comments*
Rural (off-grid) energy			
Mini-hydro	100-1,000 KW	5-10	
Micro-hydro	1-100 KW	7-20	
Pico-hydro	0.1-1 KW	20-40	
Biogas gasifier	20-5,000 KW	8-12	
Household wind turbine	0.1-3 KW	15-25	
Village-scale mini-grid	10-1,000 KW	25-100	
Solar home system	20-100 watts	40-60	

Source: REN21, "Renewables 2007: global status report", 2008.

23. The costs for many renewable energy technologies are still higher than for some conventional energy technologies. Cost estimates for new baseload wholesale power generation from conventional fuels are estimated to be 4-8 cents per kWh but could be higher for peak power and for off-grid diesel generators.[14] The higher costs, in addition to other important development and transfer barriers, indicate that there continues to be a need for more domestic and international support to promote renewable energy.

24. Technology improvements and market maturity are allowing a downward trend in the costs of most renewable energy technologies. The expectation is that this trend will continue, given the remaining technology improvement potential and current and projected global future investments in renewable energy. Some conventional technology costs have also declined, but for some technologies the potential for improvement is limited. Given the expectation of the depletion of conventional resources, higher fossil fuel prices and stricter environmental requirements, such as possible future carbon-related policies, the cost for those technologies may increase, making renewable energy technologies more cost-competitive.

25. Although the initial capital investment costs of renewable energy are often high and early stage technologies and pilot plants in particular require a lot of investment and public financial support, renewable technologies can offer prospects for a low-cost sustainable energy supply once they reach scale and gain operating experience, thereby lowering costs and prices.

26. Access to modern, fossil fuel-based energy services for the rural poor would not present a major difficulty for emissions reductions from the global perspective, given the low energy demand of the poor and the reduction of emissions related to fuelwood consumption, but given the high costs of transported fuels and electric grid extension, there exist promising low-cost opportunities for small-scale renewable energy applications, like renewable energy connected in mini-grids

[14] REN21, "Renewable energy potentials in large economies".

(wind, solar, micro-hydro and biomass gasification) and household-scale renewable energy (small wind turbines, solar home systems and micro- and pico-hydro).

27. In terms of stage of development of power generation technologies effective for CO^2 mitigation, IEA identifies geothermal and onshore wind as being among those that are already commercial and have large potential. Also with high potential but at an earlier demonstration and deployment stage are biomass integrated gasification combined cycle, biomass co-combustion, concentrating solar power, and solar photovoltaic cells. Early stage research and development is also continuing for ocean energy, fuel cells, advanced solar photovoltaic, and deep geothermal, among others.[15]

VI. Investment in new and renewable sources of energy

28. As the private sector plays a key role in providing the required technology and financing, the market environment must ensure prospects of sufficient returns on renewable energy projects. An adequate policy, legal and regulatory framework can encourage private actors, whether businesses or households, to invest in renewable energy; it can also change incentive structures for electric utilities so that they can reap profits from renewable energy. Global investment in renewable energy generation projects reached $117 billion in 2008, a growth rate of 13 per cent compared with 2007. In fact, 2008 marked the first year that investment in new power generation capacity from renewable energy technologies was greater than investment in fossil-fuelled technologies. Most of it was invested in the wind sector (with a total financial investment of $51.8 billion), followed by the solar sector ($33.5 billion), especially in the markets of the European Union, North America, China, Eastern Europe and Latin America. Financial investment increased particularly in developing countries, by 27 per cent compared with 2007, to $36.6 billion, whereas investment in developed countries fell by 1.7 per cent to $82.3 billion. New private investment in research, development and deployment increased to $13.5 billion (a 37 per cent annual increase).[16]

29. The rise of the price of crude oil to $147 per barrel in mid-July 2008 at first had positive impacts on renewable energy demand, as renewable energy was more economically promising than ever, but the roughly halving of oil prices since then, owing largely to the global recession, has reduced economic incentives for new investment, at least in the short run. Nonetheless, the International Energy Agency projects the price of crude oil to rise to more than $120 per barrel by 2030 (in nominal terms to more than $200 per barrel).[4] In the short and medium term however, the main obstacle remains the cost-competitiveness of renewables, requiring various forms of support mechanisms that stimulate private investment.

30. The global carbon market is one important way to channel private investment towards low-carbon technology in developing countries, in particular using the Clean Development Mechanism or other innovative financing mechanisms.

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[15] IEA, *Energy Technology Perspectives 2008* (Paris, OECD/IEA, 2008).

[16] United Nations Environment Programme, Sustainable Energy Finance Initiative and New Energy Finance, *Global Trends in Sustainable Energy Investment 2009* (UNEP/New Energy Finance, 2009).

31. Although the renewable energy sector resisted the global financial and economic crisis more successfully than many other sectors at first, the crisis hit the sector in the second half of 2008. Capital raised via the public stock markets for manufacturing and project pipelines decreased to $11.4 billion, a 51 per cent decrease compared with 2007. Less liquidity in global financial markets means less capital for renewable energy projects and companies, and access to finance will be limited and costly. In the first quarter of 2009, the crisis particularly affected new financial investment, which, decreased 53 per cent compared with the first quarter of 2008, to $13.3 billion.[16] Project delays and cancellations are becoming increasingly common. Energy investment flows are expected to continue to decline in the next few years, predominantly in developing countries that were already suffering from limited access to finance.[17]

32. Despite the global financial and economic crisis, and now more than ever, both public and private sector investments are required in infrastructure, technology development and production of renewable energy and greater energy efficiency, at the national and international levels, as investing in renewable energy can foster economic growth. If the sustainable energy sector grows to $630 billion by 2030, that could create more than 20 million additional direct and indirect jobs. The job creation potential is higher in developing than in industrialized countries, mainly because of lower labour costs.[18]

33. As a response to the crisis, in 2008 and 2009 Governments announced national "green" economy stimulus packages. Governments of the leading economies committed more than $180 billion to sustainable energy within their various national stimulus packages.[16] The green stimulus packages for sustainable energy of the United States ($67.7 billion) and China ($67.2 billion) are currently the largest. The stimulus packages need to be inclusive and address job creation, environmental challenges, opportunities for climate change mitigation and adaptation, financing and technology transfer to developing countries for sustainable development and poverty alleviation (General Assembly resolution 63/303, annex). A "big push" of both public and private investment is needed in developing countries to aid in convergent economic growth and the raising of domestic resources,[19] recognizing the special needs of Africa, to achieve reliable and affordable energy supplies and services, particularly in rural areas, and to promote productive uses and income-generating activities powered by renewable energy.

VII. Policy options for promoting new and renewable energy

34. The recent significant growth of renewable energy is mostly a result of more favourable policies amid increasing concerns about climate change and energy security. Especially in recent years, many countries, including industrialized and at

[17] Sebastian Fritz-Morgenthal et al., "The global financial crisis and its impact on renewable energy finance" (UNEP, Sustainable Energy Finance Initiative, New Energy Finance and the Frankfurt School of Finance and Management, 2009); IEA, "The Impact of the Financial and Economic Crisis on Global Energy Investment" (OECD/IEA, 2009).

[18] UNEP, International Labour Organization, International Organization of Employers and International Trade Union Confederation, *Green Jobs: Towards Decent Work in a Sustainable Low-Carbon World* (Nairobi, UNEP, 2008).

[19] Department of Economic and Social Affairs, "Reaching a climate deal in Copenhagen", policy brief No. 17, 2009.

least 30 developing countries, have enacted or substantially strengthened their policies or programmes and set ambitious targets aimed at the promotion of accelerated development and the increased use of new and renewable energy sources. To date more than 70 countries have renewable energy policy targets. Those targets principally aim for a certain share of renewable energy in primary energy or final energy, with targets by the 2010-2025 period, addressing electricity generation, transport, and water and space heating. Those national policies are increasingly fostering additional policies enacted by cities and local governments.

35. A variety of complementary policy tools and measures exists for promoting renewable energy use. The most common policies are feed-in laws and renewable energy quotas and portfolio standards. The feed-in laws have been enacted in some 50 countries. They oblige utilities to purchase power generated from renewables at a certain price, with a per-kilowatt-hour premium, set by the regulatory authority; they therefore offer producers of electricity from renewables a guaranteed feed-in tariff. When well designed and implemented, feed-in tariffs provide a long-term price guarantee that reduces the regulatory and market risk of renewable energy. They can spur innovation and interest and support a broad portfolio of renewable energy technologies. Owing to more predictable revenue streams from renewable energy projects, feed-in tariffs can attract investment. Wind power and solar photovoltaic especially have increased significantly as a result of feed-in tariffs.

36. Renewable energy quotas and portfolio standards exist in more than 10 countries and in about 30 states in the United States, imposing a certain minimum use of renewable energy on electricity generators and retailers and often requiring renewable energy shares between 5 and 20 per cent. The specific means of achieving renewable quotas vary considerably among countries and states. Renewable energy quotas and portfolio standards resulted in some least-cost deployment of renewable energy,[20] primarily onshore wind energy. Although such a quantity-based market mechanism can attract future investments, it often implies high administrative costs.

37. Legal guarantees for access to the electricity grid are an important precondition for private-sector investments in electricity production using new and renewable sources of energy. Most countries that have undertaken recent electricity-sector and market reforms now provide conditional access to the grid for independent power producers, including small-scale renewable energy producers. Another policy tool is net metering, allowing mainly small producers to sell back surplus power to the grid to offset their own consumption in other periods and obliging distributors to ensure the interconnections. Net metering exists in at least 10 countries and in about 40 states in the United States. In liberalized electricity markets, electricity retailers seek to sell electricity from new and renewable energy sources as "green electricity" at a premium to environmentally conscious consumers. Many countries also use public-benefit funds to finance rural electrification, renewable energy, energy efficiency or public research projects. Public-benefit funds can be generated in various ways, including through small levies on electricity transmission or consumption. Incentives offered to consumers can also stimulate investment in new and renewable sources of energy. Various incentive programmes offer cash rebates or tax credits to consumers who install

[20] This can limit the energy portfolio diversification owing primarily to investment in least-cost technologies.

their own renewable energy facilities, particularly solar home systems. Other important policy tools include public competitive bidding, direct public financing and investment to promote renewable energy. In response to the financial and economic crisis, several Governments adopted economic stimulus packages focusing on the new green employment opportunities that the renewable energy sector offers. It is important that those packages be channelled into sustainable investments in renewable energy, energy efficiency and transport.

38. Mandates for blending biofuels into vehicle fuels exist in about 40 countries. They often require blending between 2 and 5 per cent biodiesel with diesel fuel or between 10 and 15 per cent ethanol with gasoline. In recent years, several new biofuels standards and plans that target future levels of biofuel use were enacted. Other existing biofuel policies are fuel tax exemptions and production subsidies. In recent years, however, and particularly spurred by the food crisis, the sustainable production and use of biofuels has become a major concern.

39. In many countries, conventional fuel is still subsidized, distorting price signals and creating an unsustainable economic and environmental burden.[21] Instead, energy costs should be assessed in the context of the environmental and socio-economic value of the resulting development, therefore also taking into account impacts on employment and the environment and internalizing externalities related to energy deployment. That could lead to a carbon price that also captures the social costs of climate change.

40. An important overarching policy option is to integrate renewable energy into national sustainable development strategies and other comprehensive development plans that help countries achieve their economic, environmental and social objectives in an integrated manner. Owing to its integrative nature, an approach involving national sustainable development strategies allows countries to identify and harness linkages between various sustainable development objectives. In addition to climate change mitigation, energy security and energy access, countries identified linkages of renewable energy promotion with industrial competitiveness, increasing the eco-efficiency of economies, employment generation, technological innovation and global partnership.[22] Integrating renewable energy policy into national sustainable development strategies provides a framework for countries to select specific policy instruments. Since global partnership forms an integral part of the sustainable development agenda, national sustainable development strategies also enable countries to incorporate the renewable energy concerns of other countries, especially developing countries and least developed countries, into their own strategies, thereby providing a framework not only for domestic but also for international policy measures.

41. In recent years, national rural electrification policies and programmes, together with international donor programmes, have continued to emerge and progress, enabling increased percentages of the rural population to achieve access to electricity. The provision of electrification based on renewable energy can create local employment and business opportunities and improve local economies and social services, including in remote areas. It can allow further progress towards

[21] Energy subsidies in the 20 largest non-OECD countries reached almost $310 billion in 2007 (IEA, *World Energy Outlook 2008*).

[22] Department of Economic and Social Affairs, "Addressing climate change in national sustainable development strategies — common practices", 2008.

achieving the Millennium Development Goals by improving education, health and the standard of living in rural areas.

42. The existing policy options need to be reviewed periodically to ensure their effectiveness and suitability to technology maturity and, as appropriate, to phase them out where they are no longer required.

VIII. International cooperation

A. Programmes of international financial institutions

43. International financing institutions continue to play a crucial role in mobilizing financial resources for the promotion of new and renewable energy. The World Bank Group (including the International Bank for Reconstruction and Development, the International Finance Corporation, and the Multilateral Investment Guarantee Agency) has committed more than $14 billion to renewable energy and energy efficiency in developing countries since 1990. In 2008 total World Bank Group financial commitments for renewable energy, including hydropower of all sizes, and energy efficiency rose to $2.7 billion. Those commitments involved 95 renewable energy and energy efficiency projects in 54 countries and accounted for 35 per cent of total World Bank Group energy lending commitments in 2008. Compared with the 2007 level, which was $1.4 billion, that represented an 87 per cent increase.

44. The Global Environment Facility (GEF) has invested $2.7 billion to support climate change projects in developing countries, with another $17.2 billion in co-financing. More than 1 billion tons of greenhouse gas emissions, an amount equivalent to nearly 5 per cent of annual human emissions, have been avoided with support from the Global Environment Facility.

45. The regional development banks continue to contribute significantly to the promotion of renewable energy through their lending to projects. The Inter-American Development Bank in 2008 provided $1.3 billion for climate change mitigation, renewable energy and energy efficiency projects and for grants for projects under its Sustainable Energy and Climate Change Initiative. The Asian Development Bank invested $1.7 billion in clean energy projects in 2008 as part of its effort to increase energy security and to help mitigate the region's growing greenhouse gas emissions. In 2008 37.8 per cent of the infrastructure loans approved by the African Development Bank were for investment in power supply infrastructure, including hydroelectric and other renewable infrastructure.

46. More targeted efforts are needed, however, to address the major barriers affecting many developing countries, in particular least developed countries, small island developing States and countries in sub-Saharan Africa.

B. Other international programmes

47. Organizations of the United Nations system continue to support the promotion and expansion of new and renewable sources of energy in developing countries. UN-Energy, the inter-agency mechanism of the United Nations system, brings together 20 United Nations entities and agencies and the World Bank. UN-Energy continues to ensure coherence in the multidisciplinary response of the United

Nations system to the World Summit on Sustainable Development and effective engagement of non-United Nations stakeholders in implementing energy-related decisions under the Johannesburg Plan of Implementation. It aims to promote system-wide collaboration in the area of energy with a coherent and consistent approach.

48. The Department of Economic and Social Affairs continues to promote the use of new and renewable energy resources in developing countries. In 2008, the Department, in collaboration with the Government of China and other partners, organized the "Beijing high-level conference on climate change: technology development and technology transfer". At present, preparations are under way to organize the "Delhi high-level conference on climate change: technology development and transfer", in collaboration with the Government of India and other partners, to be held in New Delhi from 22 to 23 October 2009. The conferences are expected to facilitate international cooperation and dialogue on the development and transfer of clean technologies, including new and renewable sources of energy, and to address climate change challenges.

49. Renewable energy forms the core of the energy portfolio of UNDP which responds to both energy access and climate change challenges. Between 2001 and 2007, UNDP energy-related project financing rose to $1.7 billion, with about 80 per cent of the funding for renewable energy project development, clean energy market creation and catalysing carbon financing. That constituted financing of more than 300 renewable energy- and energy efficiency-related projects around the world.

50. The United Nations Environment Programme (UNEP) supports establishing commercial lending programmes for renewable energy technologies, influencing Government policies towards rural electrification programmes, improving projections about energy demand and composition, clarifying the role of risk mitigation mechanisms in financing renewable energy projects and improving data on the potential for solar and wind in developing countries. With support from the United Nations Foundation, UNEP has established the Sustainable Energy Finance Initiative to promote, facilitate and support increased investment in energy efficiency and renewable energy.

51. The United Nations Industrial Development Organization implements a large and diverse portfolio of renewable energy projects, in line with its core mandate of promoting sustainable industrial development in developing countries. The current new and renewable energy portfolio consists of 43 projects covering 33 countries in Africa, Asia and Eastern Europe.

52. The Food and Agriculture Organization of the United Nations continues to support developing countries in strengthening their institutional and human capacities to implement bioenergy programmes, including in assessing national bioenergy potentials, reviewing policy options and advising on food security and natural resources management.

53. The United Nations Human Settlements Programme (UN-Habitat) continues to address energy challenges faced by the poor. It promotes energy scale-up initiatives to facilitate access to modern energy services for the urban poor while reducing the incidence of harmful indoor air pollution within informal settlements in sub-Saharan Africa through policy change, the development of regulatory instruments and pilot demonstrations.

54. The parties to the United Nations Framework Convention on Climate Change have been meeting annually in Conferences of the Parties to assess progress in dealing with climate change and to negotiate legally binding obligations for reducing greenhouse gas emissions. The fifteenth meeting of the Conference of the Parties will be held in Copenhagen in December 2009, with the overall goal of establishing a far-reaching global climate agreement for the period from 2012. The United Nations Framework Convention on Climate Change, through the Expert Group on Technology Transfer, undertakes analysis of the gaps and barriers to financing of climate change technologies for mitigation and adaptation.

55. The United Nations Educational, Scientific and Cultural Organization (UNESCO), through its global renewable energy education and training programme, supports capacity-building activities for developing countries, especially small island developing States. Building on the implementation of the World Solar Programme 1996-2005, UNESCO has continued to provide support for national and regional training activities.

56. The United Nations regional commissions, namely the Economic and Social Commission for Asia and the Pacific, the Economic and Social Commission for Western Asia, the Economic Commission for Africa, the Economic Commission for Europe and the Economic Commission for Latin America and the Caribbean, are also continuing to significantly contribute to the promotion of new and renewable sources of energy.

57. International conferences, like the 2004 International Conference for Renewable Energies in Bonn, the 2005 Beijing International Renewable Energy Conference and the 2008 Washington International Renewable Energy Conference, provide important forums for awareness-raising and exchanges of experience that can enhance international cooperation. In 2010 the Government of India will organize the fourth International Renewable Energy Conference in New Delhi, which will focus on scaling up and mainstreaming renewable energy for energy security and climate change.

58. In 2009 the International Renewable Energy Agency was established, with its interim headquarters in Abu Dhabi. To date, 136 States have signed the Statute of the Agency (45 in Africa, 36 in Europe, 32 in Asia, 14 in the Americas and 9 in Australia/Oceania). The objective of the Agency is the promotion of a rapid transition towards the widespread and sustainable use of renewable energy on a global scale. It envisages providing practical advice and support for both developed and developing countries, thereby helping to improve frameworks and build capacity.

C. International partnerships

59. There are various international partnerships, including non-governmental organizations and other stakeholders and public-private partnerships, that contribute considerably to the promotion of new and renewable energy. For example, the Regional Centre for Renewable Energy and Energy Efficiency for the Middle East and North Africa supports policy formulation, provides a platform for regional exchange and encourages the participation of the private sector in strengthening regional industry. The DESERTEC project is a bold and ambitious plan for solar energy generation within a decade for consumption in the European Union, the Middle East

and North Africa. The Africa-European Union Energy Partnership is a long-term framework for structured political dialogue and cooperation between Africa and the European Union. South-South cooperation between developing countries can offer mutual benefits for trading partners by opening new markets, facilitating economies of scale and allowing the application of proven technologies and adapted designs that have been successfully tested and used in other developing countries.

IX. Conclusions and perspectives for the future

60. **New and renewable sources of energy play a crucial role in accelerating economic growth and employment, reducing greenhouse gas emissions, ensuring energy security and achieving sustainable development and the Millennium Development Goals. In view of the current global financial and economic crisis, climate change and the energy and food crises, renewable energy presents an opportunity to invest in long-term benefits addressing those challenges.**

61. **There is still an urgent need to improve access to reliable, affordable, economically viable, socially acceptable and environmentally sound energy services for sustainable development and poverty eradication, especially in rural and peri-urban areas. New and renewable sources of energy are a valuable solution in providing energy access. Enhanced local, national and international efforts are required to achieve access to new and renewable energy, as called for in the Johannesburg Plan of Implementation, taking into account the specific needs of developing countries, particularly in Africa.**

62. **The share of energy derived from new and renewable sources has been significantly increasing in recent years. The total share of energy derived from those sources, however, remains far below their vast potential, and there is an immediate need to tap new and renewable sources of energy. A global "push" for research, development and demonstration and later a "pull" of market deployment supported by adequate public policies are needed to lower the costs of renewable energy technologies and to increase the competitiveness of the technologies, as renewable energy may provide the most cost-effective source of energy in the long run. That requires the commitment of and ownership by not only Governments but also other relevant stakeholders, including the private sector, civil society and international organizations, to mobilize and deploy adequate financial and human resources, including through North-South, South-South and triangular cooperation. Global, regional, national and local commitments and initiatives can enhance and foster awareness, technical training, capacity-building, institutional development and technology transfer to developing countries to promote renewable energy.**[23]

63. **Adequate national policies and programmes are indispensable for accelerating the use of new and renewable energy for sustainable development. Considerable market growth of renewable energy has resulted mostly from a combination of different policy options that are stable, consistent, predictable and tailored to suit technology maturity and that are supported by national and**

[23] This was also highlighted at the interactive thematic dialogue of the General Assembly on "Energy, efficiency, energy conservation and new and renewable sources of energy", held on 18 June 2009 in New York.

local actors. Governments have enacted such policies especially in recent years, resulting in a continued rapid expansion of renewable energy use.

64. **A possible future international policy tool could be a global feed-in tariff programme. A global fund would provide guaranteed purchase prices to producers in developing countries for a period of 20 years. The price of the electricity would be lower and could be indexed to the income level of the country and of consumers. Such a programme, with the necessary investment, could accelerate demand for renewable energy equipment and infrastructure, creating employment in both developed and developing countries. With a larger production scale, unit costs would drop, leading to higher income, which in turn would translate into a higher electricity price, automatically drawing down subsidies over time. Delivery mechanisms would have to be carefully designed to ensure a broad renewable technology portfolio, support on-grid and off-grid operators and benefit targeted low-income consumers. National production capacities should be spurred through local renewable components industries, enabling the countries to meet a growing share of the increased demand for renewable energy locally, thereby benefiting from additional job creation.**[24]

65. **Policies need to create an enabling environment at all levels and stimulate investment and sustained financing. Financial resources and public and private investments at the national and international levels play a key role and must be substantially increased. The economic stimulus packages now being adopted by several Governments provide an opportunity to ensure cleaner, more sustainable growth; however, least developed countries, landlocked countries and small island developing States need additional financial and technical support from relevant institutions and bilateral and multilateral donors.**

66. **A global "Green new deal" could be a very promising way towards a sustainable future from an economic, social, environmental and security viewpoint. Such a global deal would comprise national "green" stimulus packages in developed and developing countries, targeting especially the poor and vulnerable groups; the provision of financial support for stimulus packages in developing countries to prevent contraction of their economies; and international policy coordination and collaborative programmes of Governments of developed and developing countries.**[25]

67. **There is an urgent need for a binding international agreement by the end of 2009 at the United Nations Climate Change Conference in Copenhagen to significantly reduce greenhouse gas emissions and address climate change. As the energy sector produces most of global emissions, such an agreement could stimulate a more rapid expansion of low-carbon technologies, combining, as appropriate, the increased use of new and renewable energy sources, more efficient use of energy, greater reliance on advanced energy technologies and the sustainable use of traditional biomass.**

68. **The Commission on Sustainable Development continues to play a pivotal role as a forum for discussion, information and knowledge-sharing in new and**

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[24] Department of Economic and Social Affairs, "A global green new deal for sustainable development", policy brief No. 12, 2009.

[25] Department of Economic and Social Affairs, "A global green new deal for sustainable development" 2009; UNEP, "Global green new deal", policy brief (2009).

renewable sources of energy and sustainable development that can enhance international cooperation and awareness-raising. During its fourth implementation cycle in 2010 and 2011, the Commission will consider the thematic cluster that includes transport, chemicals, waste management, mining and the 10-year framework of programmes on sustainable consumption and production patterns, providing an opportunity to review the role of new and renewable energy in advancing sustainable development in those thematic areas.

69. **A paradigm shift in the global energy market towards renewable energy is needed in order to ensure sustainable energy development, thereby creating an opportunity to tackle simultaneously the challenges of economic recovery and job creation, climate change, energy security and poverty eradication. The General Assembly may thus consider possible options and actions to promote new and renewable energy and to further international cooperation to that end.**